

# The Oblique Metaphyseal Shortening Osteotomy of the Distal Ulna: Surgical Technique and Results of Ten Patients

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## Abstract

**Background** Ulnocarpal abutment is a common condition following distal radius fractures. There are different surgical methods of treatment for this pathology: open and arthroscopic wafer procedure or an ulnar shortening osteotomy. We describe an oblique metaphyseal shortening osteotomy of the distal ulna using two cannulated headless compression screws. We report the results of 10 patients treated with this method.

**Materials and Methods** Out of 17 patients, 10 could be reviewed retrospectively for this study. Patient-rated outcomes were measured using the VAS (visual analogue scale) for pain, PRWHE (patient-rated wrist and hand evaluation) survey, and Quick-DASH (disability of arm, shoulder and hand) survey for functional outcomes. At the review we measured the range of motion (ROM) of the wrist (extension and flexion, ulnar and radial deviation, pronation and supination). Grip strength, pronation, and supination strength of the forearm was measured using a calibrated hydraulic dynamometer. ROM and strength of the affected wrist was compared with ROM and strength of the unaffected wrist.

**Surgical Procedure** Oblique long metaphyseal osteotomy of the distal ulna (from proximal-ulnar to distal-radial), fixed with two cannulated headless compression screws.

**Results** The average postoperative VAS score for pain was 23.71 (standard deviation [SD] of 30.41). The average postoperative PRWHE score was 32.55 (SD of 26.28). The average postoperative Quick-DASH score was 28.65 (SD of 27.21). The majority of patients had a comparable ROM and strength between the operated side and the non-operated side.

**Conclusion** This surgical technique has the advantage of reducing the amount of hardware and to decrease the potential hinder caused by it on medium term. Moreover, the incision remains smaller, and the anatomic metaphyseal localization of the osteotomy potentially allows a better and rapid healing.

## Keywords

- ulnocarpal abutment
- ulnar shortening
- oblique metaphyseal osteotomy
- headless compression screw

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Ulnocarpal abutment is a common condition following post-traumatic shortening of the radius.<sup>1</sup> The diagnosis is made by the patient's history of pain in prehension while pronating the forearm, clinical examination, and standard comparative radiography in Palmer view: the shoulder in 90 degree abduction, elbow in 90 degree flexion, forearm in neutral pronosupination (►Fig. 1).<sup>2</sup> The normal anatomy of the ulnocarpal junction is altered following impaction of the distal radius (►Fig. 2). The most common pathologies predisposing to the development of this impaction syndrome are the malunited distal radius fracture, excision of radial head and Essex-Lopresti injury.<sup>3</sup> Some cases can be, however, idiopathic.<sup>4</sup> Radiography shows a positive ulnar variance in frontal view with neutral pronosupination.<sup>2,5-7</sup>

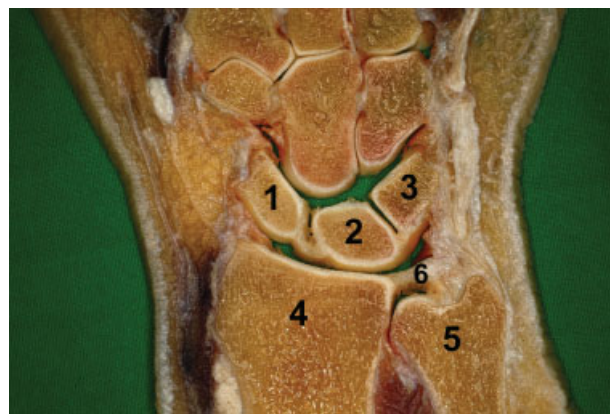
Different surgical procedures have been described for treating ulnocarpal impaction syndrome.<sup>8-11</sup> Presently, the most used surgical approaches are the open or arthroscopic wafer procedure and the ulnar shortening.<sup>12-16</sup> Osteotomies can be performed in the diaphysis or in the metaphysis, transversely or oblique. Osteosynthesis can be done in various ways. This article describes the oblique metaphyseal shortening osteotomy of the distal ulna. We used two cannulated headless compression screws for the fixation. The advantage of this surgical technique is the small amount of hardware. The metaphyseal localization of the osteotomy potentially allows shorter time for bony union to compare with the diaphyseal osteotomy.

We reviewed the results of 10 patients treated with this technique.

## Materials and Methods

The study has been approved by the local Research Ethics Committee (approval number: 1755).

This type of ulnar shortening osteotomy was performed in 17 patients. Final follow-up could eventually be done in twelve patients (8 female, 4 male). Ulnar shortening was performed in 12 wrists (6 on the right side, 6 on the left side). Six patients had a distal radius fracture in the anamnesis (►Fig. 3). Three fractures were treated conservatively and

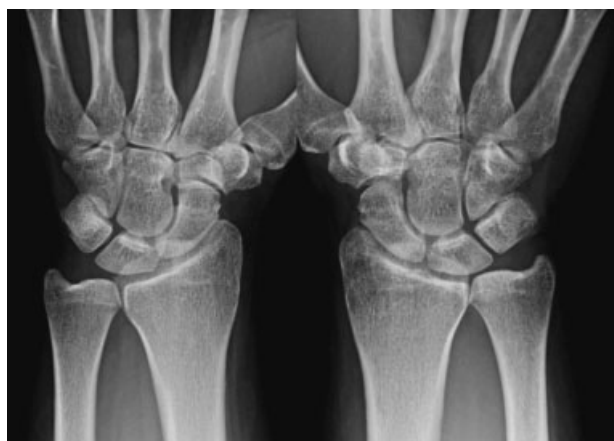


**Fig. 2** Normal anatomy of the ulnocarpal junction (frontal section of the wrist similar to the Palmer view). (1) scaphoid, (2) lunate, (3) triquetrum, (4) radius, (5) ulna, (6) triangular fibrocartilage.

three fractures were treated with pinning in the past. The diagnosis of ulnocarpal abutment was made by clinical examination (positive ulnocarpal stress test).<sup>17</sup> Diagnosis was confirmed by ulnar positive variance on comparative Palmer view radiography (►Fig. 1).<sup>2</sup> The amount of ulnar shortening varied between 2 mm and 3 mm.

Inclusion criteria include the following: (1) patients with the clinical diagnosis of ulnocarpal abutment who do not respond to conservative treatment, (2) on radiograph positive ulnar variance, and (3) adequate postoperative follow-up.

Five patients dropped out because of the very poor pre-operative and postoperative documentation. These patients were not available for adequate follow-up (postoperative measurements of ROM and strength, DASH scores, and PRWHE scores were not available). Two patients were excluded from the study: one patient subsequently underwent a Sauvé-Kapandji procedure at an outside institution, in the other patient a revision osteosynthesis was performed



**Fig. 1** Comparative frontal radiography in Palmer view.



**Fig. 3** Recent distal radius fracture with shortening of the radius (left side). Consolidation of a distal radius fracture with shortening of the radius (right side).

with plate and screws after secondary displacement of the osteotomy of the distal ulna after a fall on the hand.

The mean age of the ten patients included in the study was 47.7 years (range, 34–57). Mean follow-up time was 64.2 months (range, 25–90).

Patient-rated outcomes were measured using VAS (visual analogue scale) for pain, PRWHE (patient-rated wrist and hand evaluation) survey, and Quick-DASH (disability of arm, shoulder, and hand) survey for functional outcomes.

The VAS was scored from 0 (no pain) to 100 (maximal pain). In the PRWHE survey and the DASH survey, the outcome was measured from 0 to 100. Lower scores corresponding to less disability.

At the time of final follow-up we measured the range of motion (ROM) of the wrist (extension and flexion, ulnar and radial deviation, pronation and supination). Measurements were performed using a goniometer. For evaluation and documentation of ROM we used the neutral-zero-method. Grip strength was measured in kilograms using a calibrated hydraulic hand dynamometer (Baseline Fabrication Enterprises Inc., New York, NY). Pronation and supination strength was measured using the baseline hydraulic wrist dynamometer (White Plains, New York, NY). On this device the strength reading can be viewed as kilograms. ROM and strength of the affected wrist was compared with ROM and strength of the unaffected wrist.

At the time of final follow-up, standard radiographs of the wrist were taken in profile and in frontal Palmer view.<sup>2</sup> Radiographs were analyzed regarding the postoperative ulnar variance and healing of the osteotomy (consolidation).

The measurements were done by a single observer, an orthopedic surgeon.

## Surgical Procedure

Surgery was performed under tourniquet control and long-acting plexus anesthesia. We believe that this type of anesthesia protects the patient significantly against potential complex regional pain syndrome type 1. Longitudinal incision was made over the distal one quarter of the ulna on the dorsal-ulnar aspect of the distal forearm. The distal ulna was exposed between the extensor carpi ulnaris and the extensor digiti minimi. The ideal position and direction of the osteotomy was verified under fluoroscopy, holding the forearm in neutral pronosupination. An oblique osteotomy was performed, with a new saw blade under the lowest possible oscillating speed and constant irrigation, from proximal-ulnar to distal-radial. We always aimed to perform an osteotomy with an inclination between the 30 degrees and 45 degrees. The surface contact area between the fragments can be increased with a more inclined osteotomy. (►Fig. 4). The amount of shortening varied between 2 mm and 3 mm. First the osteotomy was temporarily fixed with two Kirschner wires (part of the ancillary of a cannulated screw system) placed perpendicularly to the osteotomy. Two cannulated self-tapping and self-drilling headless compression screws completed the interfragmentary osteosynthesis. The whole procedure was performed under fluoroscopic control. The



**Fig. 4** Long oblique metaphyseal osteotomy of the distal ulna performed in a neutral pronosupination.

pulley of the sixth extensor compartment and the extensor retinaculum were sutured. An aesthetic closure of the skin was performed with an intradermal suture. An upper arm cast was applied.

## Postoperative Management

A total of 6 weeks of immobilization postoperatively: 2 weeks of upper arm cast, 2 weeks of Munster cast and finally 2 weeks of forearm cast. Six weeks after the surgery, all patients started with mobilization of the wrist and the forearm. Seven patients needed physiotherapy performed by a hand therapist. In three cases, the special hand therapy was not necessary, self-mobilization exercises were sufficient.

## Results

The available preoperative and postoperative data are summarized in ►Tables 1–3.

**Patient-rated outcomes.** All patients reported a reduction of pain. The average postoperative VAS score for pain was 23.71 (SD of 30.41). The average postoperative PRWHE score was 32.55 (SD of 26.28). The average postoperative Quick-DASH score was 28.65 (SD of 27.21) (►Table 4). Preoperative DASH scores and PRWHE scores are not available.

ROM and strength of the affected wrist was compared with the ROM and strength of the unaffected wrist. Functional results were divided in three categories: *comparable*,

**Table 1** Range of motion and strength of the operated side preoperatively and postoperatively

Patient	Operated side	Preop. E/F	Postop. E/F	Preop. UD/RD	Postop. UD/RD	Preop. P/S	Postop. P/S	Preop. grip strength	Postop. grip strength	Postop. P/S strength
1	right	70/0/78	68/0/67	30/0/20	39/0/12	90/0/90	82/0/90	11	22	46/33
2	left	38/0/50	36/0/48	14/0/14	10/0/15	no data	90/0/44	24	18	60/40
3	left	no data	60/0/72	no data	32/0/26	no data	90/0/68	no data	30	60/33
4	left	56/0/66	60/0/68	24/0/20	32/0/34	no data	80/0/84	no data	50	130/84
5	left	82/0/73	70/0/68	31/0/40	30/0/27	no data	90/0/71	36	30	58/26
6	left	70/0/66	72/0/70	42/0/16	36/0/20	72/0/90	90/0/90	24	24	40/24
7	right	54/0/37	60/0/64	20/0/12	30/0/24	90/0/82	90/0/73	28	39	72/28
8	right	53/0/56	55/0/68	20/0/24	32/0/26	90/0/80	90/0/65	3	35	32/39
9	right	15/0/55	33/0/24	15/0/0	25/0/5	75/0/40	86/0/33	5	34	136/109
10	right	56/0/54	43/0/48	16/0/20	28/0/21	no data	70/0/18	18	19	16/12

Note: Some preoperative data are missing; the pronation and supination strength preoperatively was not measured.  
Abbreviations: E, extension; F, flexion; P, Pronation; RD, radial deviation; S, supination; UD, ulnar deviation.

*moderate difference*, and *significant difference*. It was graded as *comparable* if the difference in ROM is less than 10 degrees, in grip strength is less than 5 kg, and in pronation and supination strength is less than 10 kg. It was graded as *moderate difference* if the difference in ROM is between 10 and 20 degrees, in grip strength is between 5 and 10 kg, and in pronation and supination strength is between 10 and 20 kg. It was graded as *significant difference* if the difference in ROM is more than 20 degrees, in grip strength is more than 10 kg, and in pronation and supination strength is more than 20 kg (►Table 5).

Extension of the wrist was comparable in six patients. Flexion of the wrist was comparable in seven patients. Ulnar deviation of the wrist was comparable in eight patients.

Radial deviation of the wrist was comparable in seven patients. Pronation of the forearm was comparable in nine patients. Supination of the forearm was comparable in six patients.

Grip strength of the hand was comparable in six patients.

Pronation strength was comparable in seven patients. Supination strength was comparable in six patients.

Consolidation time of the osteotomy was between 3 and 6 months (►Fig. 5). We used two radiographic criteria to evaluate the fracture healing: (1) first time when the callus becomes visible on radiograph and (2) complete filling of the osteotomy gap on radiograph (consolidation time). In all cases the callus became visible after 6 weeks. In nine patients on the radiograph which was made 18 weeks after the

**Table 2** Patient-rated outcomes (preoperative DASH and PRWHE are not available), duration of follow-up, time of consolidation

Patient	Postop. Quick-DASH	Postop. PRWHE	Preop. VAS for pain	Postop. VAS for pain	Duration of follow-up (mo)	First time when the callus becomes visible on radiograph (wk)	Complete filling of the osteotomy gap on radiograph (consolidation time; wk)
1	13, 6	16/100	97, 56	3, 65	31	6	18
2	50	53, 5/100	85, 36	71, 95	90	4	12
3	61, 4	47/100	54, 87	1, 21	89	6	18
4	6, 8	7/100	95, 12	3, 65	78	6	18
5	45, 5	53, 5/100	80, 48	39, 63	27	6	18
6	0	7, 5/100	65, 85	1, 21	69	6	18
7	0	0/100	100	0	79	6	18
8	2, 3	16, 5/100	89, 02	0	25	4	18
9	36, 4	46, 5/100	67, 07	42, 68	90	6	24
10	70, 5	78/100	83, 41	73, 17	64	6	12

Abbreviations: PRWHE, patient-rated wrist and hand evaluation; quick-DASH, disability of arm, shoulder and hand; VAS, visual analogue scale.

**Table 3** Comparison of range of motion and strength of the operated and the non-operated side

Patient	E/F operated side	E/F non-operated side	UD/RD operated side	UD/RD non-operated side	P/S operated side	P/S non-operated side	Grip strength operated side	Grip strength non-operated side	P/S strength operated side	P/S strength non-operated side
1	68/0/67	72/0/60	39/0/12	40/0/15	82/0/90	90/0/90	22	28	46/33	50/40
2	36/0/48	40/0/35	10/0/15	15/0/15	90/0/44	90/0/46	18	34	60/40	94/84
3	60/0/72	59/0/64	32/0/26	40/0/24	90/0/68	90/0/76	30	8	60/33	11/14
4	60/0/68	48/0/52	32/0/34	24/0/29	80/0/84	80/0/90	50	50	130/84	130/120
5	70/0/68	82/0/73	30/0/27	31/0/40	90/0/71	90/0/86	30	32	58/26	60/24
6	72/0/70	70/0/66	36/0/20	42/0/16	90/0/90	72/0/90	24	25	40/24	40/32
7	60/0/64	70/0/76	30/0/24	44/0/22	90/0/73	90/0/82	39	39	72/28	64/38
8	55/0/68	72/0/70	32/0/26	35/0/22	90/0/65	90/0/82	35	36	32/39	58/54
9	33/0/24	60/0/36	25/0/5	25/0/28	86/0/33	86/0/61	34	55	136/109	92/74
10	43/0/48	62/0/70	28/0/21	41/0/32	70/0/18	90/0/82	19	32	16/12	47/44

Abbreviations: E, extension; F, flexion; P, Pronation; RD, radial deviation; S, supination; UD, ulnar deviation.

**Table 4** Patient-rated outcomes (Quick-DASH, PRWHE, VAS)

	mean	SD
Quick-DASH	28.65	27.21
PRWHE	32.55	26.28
VAS	23.71	30.41

Abbreviations: PRWHE, patient-rated wrist and hand evaluation; quick-DASH, disability of arm, shoulder and hand; SD, standard deviation; VAS, visual analogue scale.

surgery, the osteotomy gap was completely filled. In one patient the osteotomy gap was completely filled after 24 weeks. We had no nonunions in this series.

In five patients the screws were removed due to hardware irritation.

## Discussion

Milch was the first who described in 1941 the importance of ulnar shortening osteotomy in the treatment of ulnocarpal abutment.<sup>18</sup> Since then many techniques of surgical shortening of the ulna have been developed.<sup>19–22</sup>

The most popular methods are the open or arthroscopic wafer procedure and the diaphyseal shortening osteotomy with plate and screw fixation.<sup>23–27</sup> This article describes the oblique metaphyseal shortening osteotomy of the distal ulna, starting proximal-ulnar, and ending distal-radial just proximal to the ulnar head, respecting an inclination between 30 and 45 degrees. The surface contact area between the fragments can be increased with a more inclined osteotomy. This technique is a modification (the mirror) of the Sennwald-Della Santa osteotomy, using a minimal fixation with two headless compression screws.<sup>28</sup> We report the results of the first 10 patients treated with this technique.

**Table 5** Comparison of range of motion and strength between the operated wrist and the non-operated wrist (number of patients)

	Comparable	Moderate difference	Significant difference
Extension	6	3	1
Flexion	7	2	1
Ulnar deviation	8	2	0
Radial deviation	7	2	1
Pronation	9	1	0
Supination	6	2	2
Grip strength (Jamar)	6	1	3
Pronation strength	7	0	3
Supination strength	6	1	3



**Fig. 5** Osteotomy of the distal ulna one day after surgery with cortical overriding of the translated bone portion ulnarly (left side [L]). Consolidation of the osteotomy 5 months after surgery (right side).

Constantine et al compared wafer resection and ulnar shortening osteotomy.<sup>29</sup> They found no difference in clinical results (ROM, grip strength, and pain relief).

Pechlaner described an oblique osteotomy of the ulnar head.<sup>30</sup> Decompression of the ulnar compartment of the wrist is achieved by increasing the distance between the ulnar head and the proximal row of the carpus.

Lautenbach et al have reported good results of transverse ulnar shortening osteotomy using a compression device and an ulnodorsal approach.<sup>31</sup>

Khoury et al described a wedge osteotomy of the distal metaphysis of the ulna.<sup>32</sup> They used a headless compression screw for fixation.

Horn described an oblique osteotomy at diaphyseal level of the ulna using only screws for fixation.<sup>33</sup>

Baek et al have investigated the long-term clinical and radiological outcomes of ulnar shortening osteotomy with at least 5-years follow-up.<sup>34–36</sup> They reported good clinical outcomes despite the osteoarthritic changes of the distal radio-ulna joint.

Katz et al, in their systematic review of the literature, reported a higher complication rate in the ulnar shortening osteotomy group than in the wafer procedure group.<sup>10</sup>

In our study, different patient-rated outcomes measures (VAS, PRWHE, quick-DASH) were used to evaluate the results of our surgical technique. At the time of final follow-up we measured the ROM of the wrist, the grip strength, and the pronation-supination strength. The clinical outcomes of our surgical procedure are comparable to the results of other methods. The mean follow-up time was 64.2 months (range, 25–90).

The described technique has advantages at different levels. First, if it is performed correctly, once the osteotomy

is achieved the distal fragment sets automatically in the correct position without the need of pulling it. Second, the localization in a well vascularized metaphyseal region of the distal ulna provides better and rapid healing. We had no nonunions in this series, which illustrates the importance of performing the technique likewise. Consolidation time varied between 3 and 6 months. We used two radiographic criteria to evaluate the fracture healing: (1) first time when the callus becomes visible on radiograph; and (2) complete filling of the osteotomy gap on radiograph (consolidation time). In all cases the callus became visible after 6 weeks. In nine patients, on the radiograph which was made 18 weeks after the surgery, the osteotomy gap was completely filled. In one patient the osteotomy gap was completely filled after 24 weeks. Finally, due to the (small) amount of hardware, hinder is minimized. Furthermore, even when necessary, removal of these screws is very unlikely to be the cause of iatrogenic fractures in the immediate postoperative period compared with the plate and screws used in a diaphysis. We could not avoid the other known complication of the ulnar shortening osteotomy, the hardware irritation. In five patients the screws were removed. In these patients, a painful palpation above the head of the screws was experienced, probably through irritation of the extensor carpi ulnaris tendon. After removal of the hardware the pain disappeared.

## Conclusion

The results of the described technique of ulnar shortening osteotomy (VAS, PRWHE, DASH, ROM, strength) are comparable to the results of other validated ulnar shortening techniques. The advantages of our surgical method are the small amount of hardware and the smaller incision. The oblique direction and the metaphyseal localization of the osteotomy potentially allow better and rapid healing (consolidation). There were no nonunions in this series. This surgical technique is a valuable alternative for the treatment of ulnocarpal abutment.

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None.

## Note

This study received the approval of the Leading Ethics Committee number 1755 of the AZ Sint-Jan AV Brugge-Oostende, campus Brugge, Brugge, Belgium.

## Conflict of Interest

Jean F. Goubau is financially supported by Synthes–Johnson & Johnson Corporate, New Brunswick, New Jersey, U.S.A. and his payment from the company consists only of consultancy fees and research support. Jean F. Goubau receives royalties for medical devices from Stryker Corporation, Kalamazoo, Michigan, U.S.A.

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